CONTROLLING THE QUALITY OF DIFFERENT VEGETABLE AND FISH OILS BY MEANS OF RAMAN SPECTROSCOPY

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Abstract: This contribution reports on a Raman spectroscopic study of different plant and fish oils. Differences in the quality of the oil samples are discussed.

Raman spectroscopy is a very powerful tool to study the quality of vegetable [1,2] as well as fish oils [3]. Edible oils consist mainly of phosphine lipids which are esters of different fatty acids. Two important parameters concerning the quality can be proofed by means of Raman spectroscopy. Firstly Raman spectroscopy allows one to distinguish between the naturally occurring *cis* C=C double bonds and *trans* C=C double bonds being present for example after fat hardening processes or after a treatment with very high temperatures. Fatty acids that contain *trans* C=C double bonds increase the amount of LDL-Cholesterol – the physiological unfavourable form – and decrease the HDL-Cholesterol – the favourable cholesterol form. Secondly another important quality criteria is the degree of unsaturated fatty acids of the oil. This is important since a high content of double bonds is supposedly good to prevent diseases like e. g. arteriosclerosis. This degree is also accessible applying Raman spectroscopy.

In this study we provide a Raman spectroscopic analysis concerning the above mentioned points for different kinds of oils. In particular olive oil extracted from *Olea europaea* L. that is cultivated in Italy, Spain and Greece, sun flower oil extracted form *Helianthus annuus* L. which comes from Northern America and fish oil obtained from salmon (*Salmo salar*) or herring (*Clupea harengus*) were investigated. Olive oil contains a high amount of oleic acid while the main components of sun flower oil are linoleic acid (48 – 74 %), and oleic acid (14 – 39 %). Fish oil contains eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). [4]

The Raman spectra of these oils are shown in figure 1 (olive oil (a), sun flower oil (b), different fish oils of two different suppliers (c and d)). The band at 1655 cm^{-1} being present in all four spectra is typical for a ν $(C=C)_{cis}$ stretching vibration of unsaturated fatty acids. However, spectrum (d) shows an additional signal at 1627 cm^{-1}. This peak might be assigned to the ν (C=C) stretching vibration of conjugated double bounds.

The ratio between C=C double bonds and C-C single bonds can be obtained by calculating the peak area ratio of the bands at 1263 cm^{-1} 1300 cm^{-1} which are due to the δ_{ip} (=CH) vibration and the τ_{ip} (CH) vibration, respectively. Olive oil mainly consists of monounsaturated oleic acid whereas sun flower oil shows a high content of linoleic acid having the same chain length like oleic acid but consisting of one more C=C double bond. This can be seen in the Raman spectrum by comparing the peak area ratio of the above mentioned Raman bands (see marked area in Figure 1). In fish oil a higher content of double bonds can be found since the main components of this oil are eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). These two compounds exhibit a very high number of double bonds (see marked area in Figure 1).

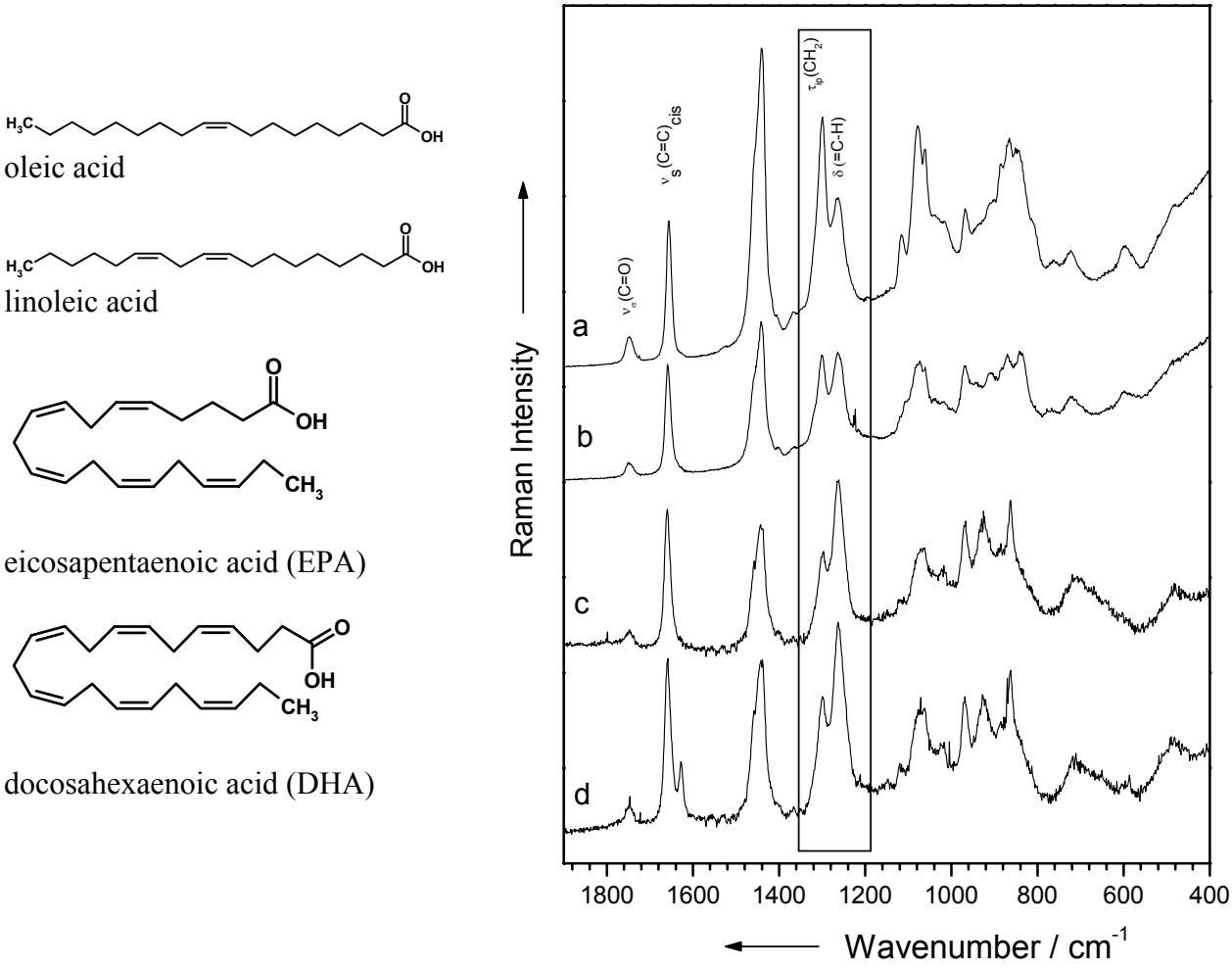

Fig. 1. Raman spectra of different kinds of oil. The spectra (a) and (b) are from plants as olive and sunflower. Raman spectra of different samples of fish oil are also shown (c, d).

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